

THE WEATHER AND CIRCULATION OF FEBRUARY 1952¹

A Month with a Pronounced Index Cycle

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One of the most interesting features of the circulation of February 1952 was the occurrence of a pronounced cycle in the zonal index during the month. The index cycle is defined as a gradual decline of the strength of the temperate-latitude westerlies from comparatively high to low values, followed by a similar rise. Namias [1] has shown that cycles lasting several weeks are prone to occur during February and March. This year the minimum point in the index cycle occurred near the middle of February, at least ten days earlier than all but one period studied by Namias, and more than twenty days earlier than the cycle in 1951 which was described by the author [2].

Figure 1 shows the time variation of the 5-day mean values of the temperate-latitude 700-mb. zonal index for the Western Hemisphere. The beginning of the index cycle may be defined as the high point in the graph, a value of 14.2 m/sec (more than 3 m/sec above normal) observed during the period centered on February 1. Incidentally this was the highest zonal index value observed during any 5-day mean period of the entire 1951-52 winter season. Note how the index values declined almost steadily until the very low value of 4.7 m/sec (more than 5 m/sec below normal) was reached on February 18. After a fairly slow rise during the next two weeks the index reached a value slightly above normal again on March 3.

Figure 2 depicts more completely the variation of the zonal westerlies during this index cycle. It is evident that the slowdown of the temperate-latitude westerlies was associated with a gradual shift of the major westerly belt southward from 43° N., where its peak speed was reached on February 1, to 33° N. by February 15. Thus, by February 18 a minimum speed of only 2 m/sec was found at latitude 48° N. After the minimum in the index cycle the average westerly wind belt was characterized by two distinct maxima, one axis shifting north of 40° N. while the other remained between latitudes 30° and 35° N. until it disappeared during the first week in March. Another noteworthy feature shown in this wind speed time section is the development of a secondary axis of maximum westerly winds between latitudes 60° and 70° N. in mid-February, which moved north of 70° N. by month's end. The behavior of the Western Hemisphere

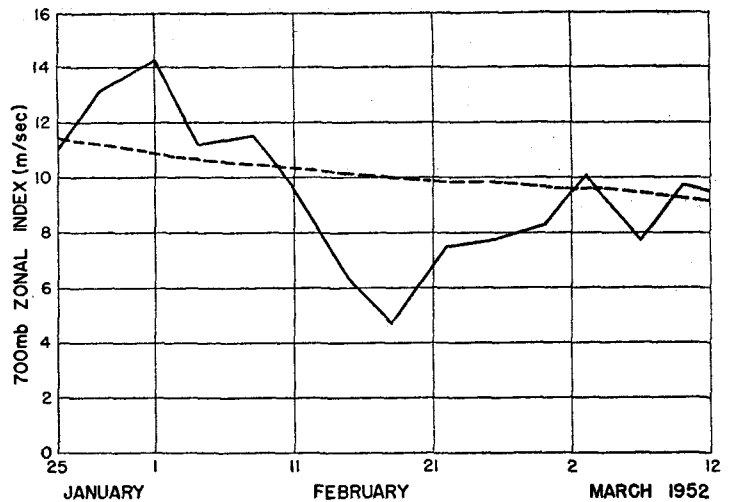


FIGURE 1.—Variation of temperate-latitude zonal index (average strength of zonal westerlies in m/sec between 35° N. and 55° N.) at 700 mb. over the Northern Hemisphere from 0° westward to 180° longitude. Solid line connects 5-day mean zonal index values (plotted at middle of 5-day period and computed twice weekly) for period from January 25 to March 12, 1952. Dashed line shows variation of monthly normal zonal index values for same period.

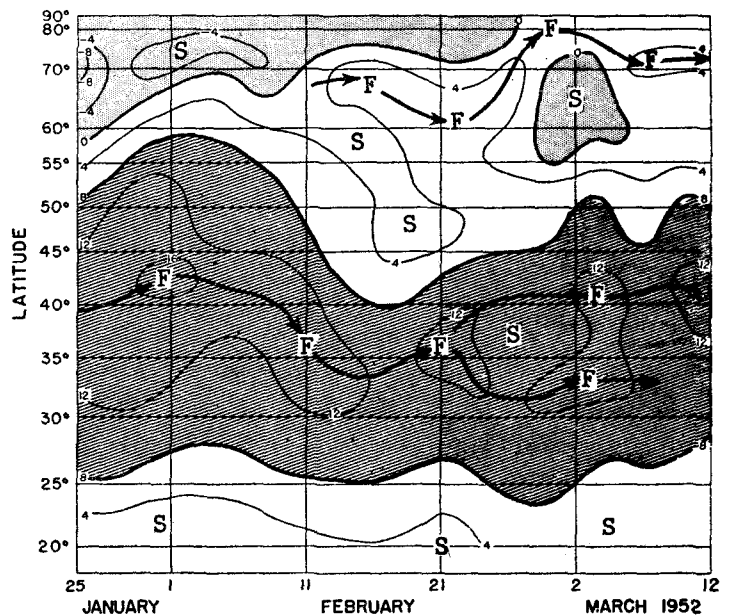


FIGURE 2.—Time-latitude section of 5-day mean zonal wind speed in Northern Hemisphere (averaged from 0° westward to 180° longitude) in m/sec at 700 mb. for period from January 25 to March 12, 1952. Isopleths are drawn at intervals of 4 m/sec. Areas with speeds greater than 8 m/sec are hatched; areas with negative speeds (easterlies) are stippled. Maximum speed centers are labeled "F", minima are labeled "S". Heavy arrowed lines mark latitudinal position of axes of maximum wind speed with time.

¹ See Charts I-XV following p. 35, for analyzed climatological data for the month.

westerlies during this year's index cycle differed in one major respect from the cycle of February-March 1951 [2]. This year the major westerly belt shifted bodily southward, whereas last year the major westerlies shifted far to the north, and only then did a new westerly wind maximum develop at low latitudes. Whether this difference has any significance in terms of the subsequent behavior of the general circulation in each of the given years has not been determined. During both years, however, the westerly wind maximum was found at low latitudes near the time of the low point of the index cycle. This characteristic, originally emphasized by Rossby and Willett [3], was found by Namias [1] to apply during five out of six February-March index cycles from 1944 to 1949.

With such a large-scale, long-period variation in the westerlies occurring during the month of February it is not surprising that there were marked variations in the general circulation patterns during the month. Since the initial higher index phase of the cycle dominated much of the first half of the month while the lower index phase prevailed through most of the second half, the mean 700-mb. maps for the two halves of February provide an interesting contrast in circulation features (fig. 3). During approximately the first 15 days of the month the mean circulation was characterized by relatively fast westerly flow in an approximately sinusoidal wave pattern extending over almost three-fourths of the Northern Hemisphere from the east coast of Asia eastward to Europe (fig. 3A). Only over Asia was there a significant split in the major meandering westerly stream.

On the other hand, by the second half of the month, the circulation over about three-fourths of the Northern Hemisphere was dominated by anticyclonic conditions in northerly latitudes and cyclonic conditions at lower latitudes (fig. 3B). Warm closed Highs were located over northern Siberia and the northeastern Atlantic, and deep cold Lows were situated over southeastern Europe and the Gulf of St. Lawrence. Over North America a broad ridge covered central Canada, while cyclonic circulation was found to its south over the southern half of the United States. All of these features are rather typical examples of blocking action, of which low zonal index values are generally symptomatic. A split in the westerlies is strongly in evidence in figure 3B, with the higher latitude westerly belt extending from the Canadian Arctic eastward into the Siberian Arctic, while the stronger and more extensive belt in southerly latitudes extended almost unbroken from the western United States eastward through the Atlantic and the Mediterranean to the China coast. High index conditions with a single band of westerlies still prevailed over most of the Pacific in association with a deep Aleutian Low located near its normal position. Thus, as in the case of the March 1951 index cycle [2], the temperate westerlies over one sizable portion of the Northern Hemisphere were apparently undisturbed by widespread blocking action which had infected all other portions

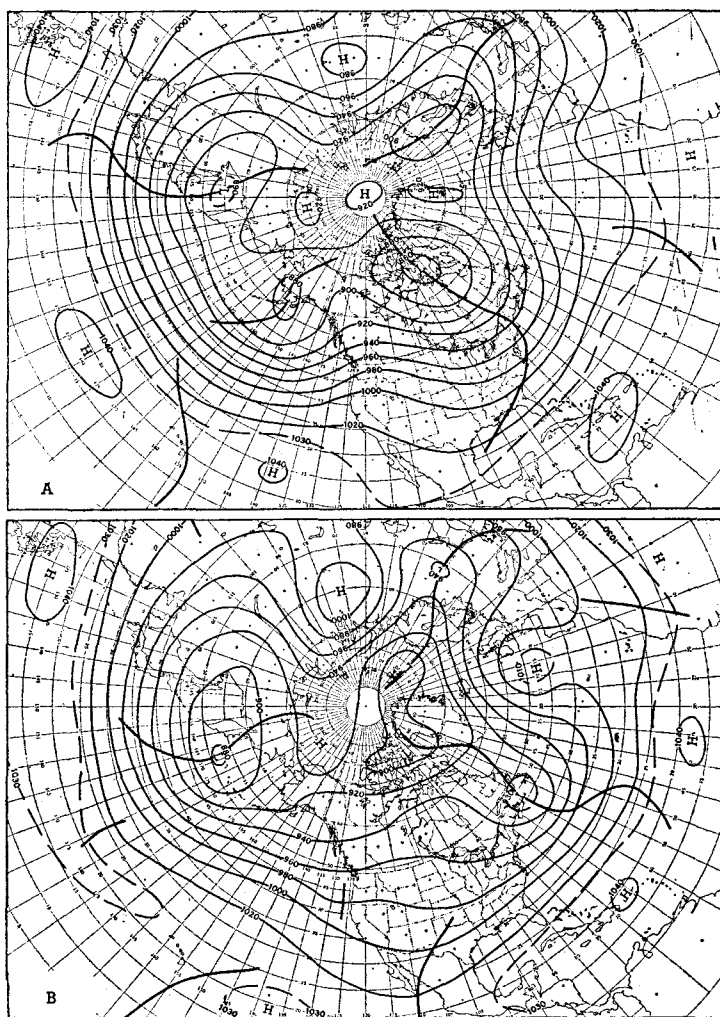


FIGURE 3.—Fifteen-day mean 700-mb. charts for (A) January 30–February 13, and (B) February 13–27, 1952. Contours at 200-foot intervals are shown by solid lines, selected intermediate contours at 100-foot intervals by dashed lines, and minimum latitude trough locations by heavy solid lines.

of the hemispheric circulation. It would be interesting to determine whether in all index cycles the extent of blocking action is limited in like fashion. A cursory inspection of charts of the low index stage of the index cycle (fig. 3 of [1]) reveals that in most cases which had sufficient hemispheric data a considerable area of the hemisphere was still dominated by fairly rapid westerly flow at middle latitudes. These findings may fit in with the idea of Rossby and Rex that the initiation of blocking is "more probable when a strong and relatively narrow westerly current system aloft prevails over the upstream area" [4]. Thus, if one considers that blocking usually spreads progressively upstream while the initial block persists [1, 5], it is obvious that there must be one longitudinal area of the hemisphere upstream from which strong westerlies do not exist. Presumably, the existing westerlies in this region would not decay as long as the westerlies are split and disorganized upstream. Therefore, a wave of blocking could not complete its circumpolar

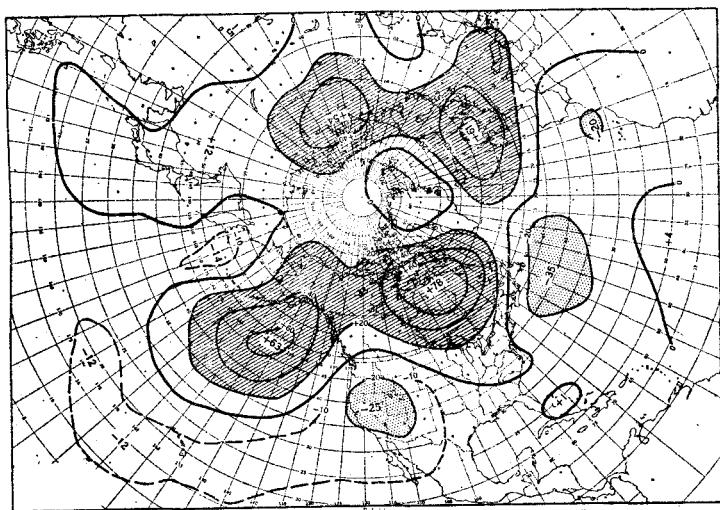


FIGURE 4.—Change in 15-day mean 700-mb. height from the period January 30-February 13, 1952 (fig. 3A) to the period February 13-27, 1952 (fig. 3B). Change centers and isopleths are labeled in tens of feet. Regions with height rises greater than 200 feet are hatched; regions with height falls greater than 200 feet are stippled.

tour until the original block had been replaced by fast westerlies.

A quantitative picture of changes in the 700-mb. height pattern from the first to the second half of February is given in figure 4. The most striking features of this chart are four large areas of height rise located in northern Siberia, northwestern Europe, eastern Canada, and the northeast Pacific. The first three of these were centered in regions where warm anticyclones or ridges developed at higher latitudes. The rise center in the northeast Pacific was associated with a marked change from strong cyclonic to anticyclonic flow and was probably a manifestation of blocking action in that area too. Of almost equal importance are the well-defined fall areas at lower latitudes in the western Atlantic and western United States. The relatively minor changes in eastern Asia and the western Pacific are also of interest in connection with the foregoing discussion of continued strong temperate-latitude westerly flow in that region.

Since the rise area centered over Hudson Bay was the most intense in the Northern Hemisphere, while fall centers to its southwest and southeast were likewise the most pronounced, it is apparent that the greatest regional decline in mid-latitude westerlies from the first to second halves of the month occurred over North America and the western Atlantic. This great change in circulation pattern had marked effects on the weather over the United States during the month. Representative of the changes in temperature from the first to the second halves of the month are the weekly temperature anomalies for the weeks ending February 12 and 26 (fig. 5). Figure 5A shows general warmth over virtually the entire United States with the greatest temperature anomaly in the northern Plains and along the eastern slopes of the Rockies. This is a rather typical pattern associated with fast westerly flow across the Continental Divide in western

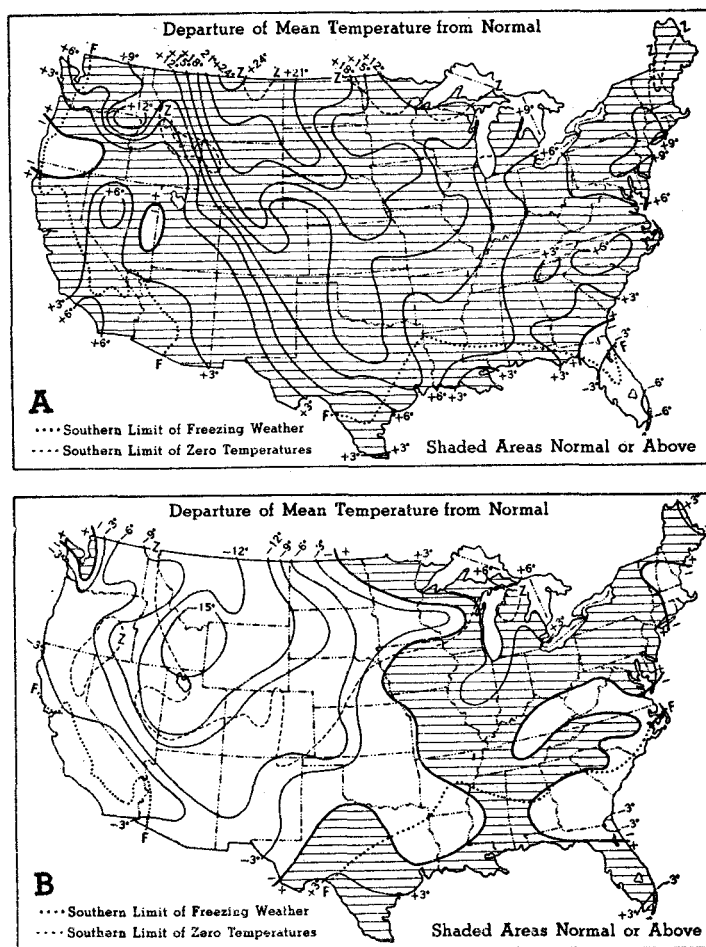


FIGURE 5.—Departure from normal of weekly mean surface temperatures in °F. for weeks ending (A) February 12 and (B) February 26, 1952. (From U. S. Weather Bureau, *Weekly Weather and Crop Bulletin* for above dates.)

Canada and northwestern United States. Two weeks later (fig. 5B), as the bottom of the index cycle was reached, temperatures were below normal in about two-thirds of the United States. Figure 6 portrays graphically the change to colder weather which took place between these two periods over practically the entire Nation. Note the tremendous fall in temperature anomaly in northern portions of the Rocky Mountain and Plains States. Miles City, Mont. experienced the maximum change, -39° F. Such large changes toward colder weather in the United States are quite characteristic of a drop from relatively high to extremely low zonal index values. The close connection between extreme values of zonal index, both high and low, and temperature regimes over the United States was pointed out twelve years ago in pioneering studies of extended forecasting [6].

Close inspection of Chart X reveals some of the effects of blocking and the index cycle on storm tracks during the month, especially in the eastern United States and western Atlantic. It can be seen that cyclones were fairly numerous in eastern Canada and the North Atlantic States in the first half of the month, when a deep trough

and strong westerlies were located over the region (fig. 3A). However, in the second half of the month there was almost a complete absence of cyclones in the same region while several storm centers moved through the Middle and South Atlantic coastal regions of the United States. This is readily explained by the appearance of the 700-mb. flow during the second half of the month (fig. 3B), when, as described earlier, anticyclonic conditions prevailed over eastern Canada and the westerlies were flat and strong at lower latitudes.

Three storms which passed through the Gulf of Mexico made a major contribution to the heavier-than-normal precipitation amounts observed along most of the Gulf Coast region and the lower Mississippi Valley (Chart III-B). Two of these storms proceeded northeastward off the East Coast. The one which formed a new center off Hatteras on the 16th deepened rapidly and led to intensive precipitation along the Middle and North Atlantic coast. In much of central and southern New England and eastern New York this produced the heaviest snowfall of the winter. The other storm, which left the Gulf of Mexico on the 26th, brought very heavy snow to extreme southeast New England.² Consequently New England reported abnormally heavy snowfall for February (Chart V-A). Nevertheless, precipitation on the whole in the Middle and North Atlantic States was subnormal (Chart III-B). These and most other regions of subnormal precipitation amounts (i. e., Great Lakes Region, Southwest, Kansas, and west Texas) were located under prevailing northwesterly flow at 700 mb. on the monthly mean chart (fig. 7).

Excessive precipitation in the Northern Plains and northern Rocky Mountain States (Chart III-B) is difficult to explain from the upper level monthly mean pattern (fig. 7). However, the area was located to the north of the paths of several cyclones during the month (Chart X). Much of this precipitation occurred with the slow-moving storm centered in Colorado on the 18th. This storm produced sizable amounts of snow in the entire region with the heaviest snowfall in parts of South Dakota and Minnesota. This cyclone was retarded in its eastward motion by an intense anticyclone over Hudson Bay (Chart IX). This High was associated with the previously mentioned large-scale blocking action operating over eastern Canada as the zonal index reached low values. The history of this High is rather remarkable, as may be determined by careful examination of Chart IX. Two notable features are worth mentioning. First, the high center meandered through eastern Canada for more than 15 days after it was first identified as a weak closed center late on the 9th northwest of Hudson Bay, finally crossing Newfoundland on the 25th. Second, rapid anticyclogenesis took place as the High lay over Hudson Bay between the 11th and 13th when the central pressure increased from 1016 to

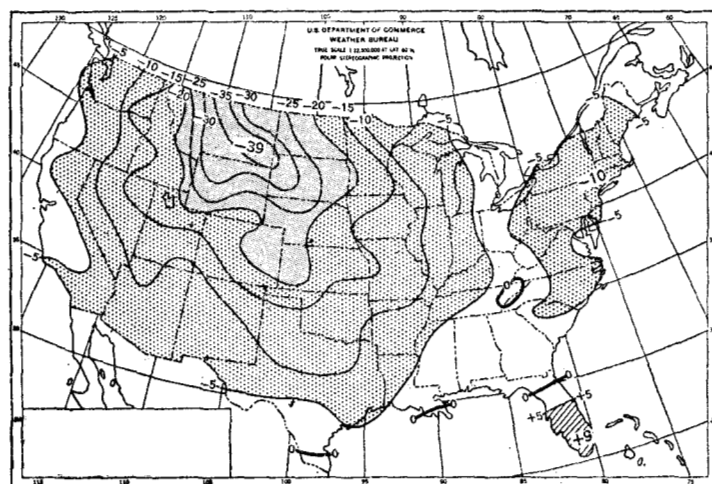
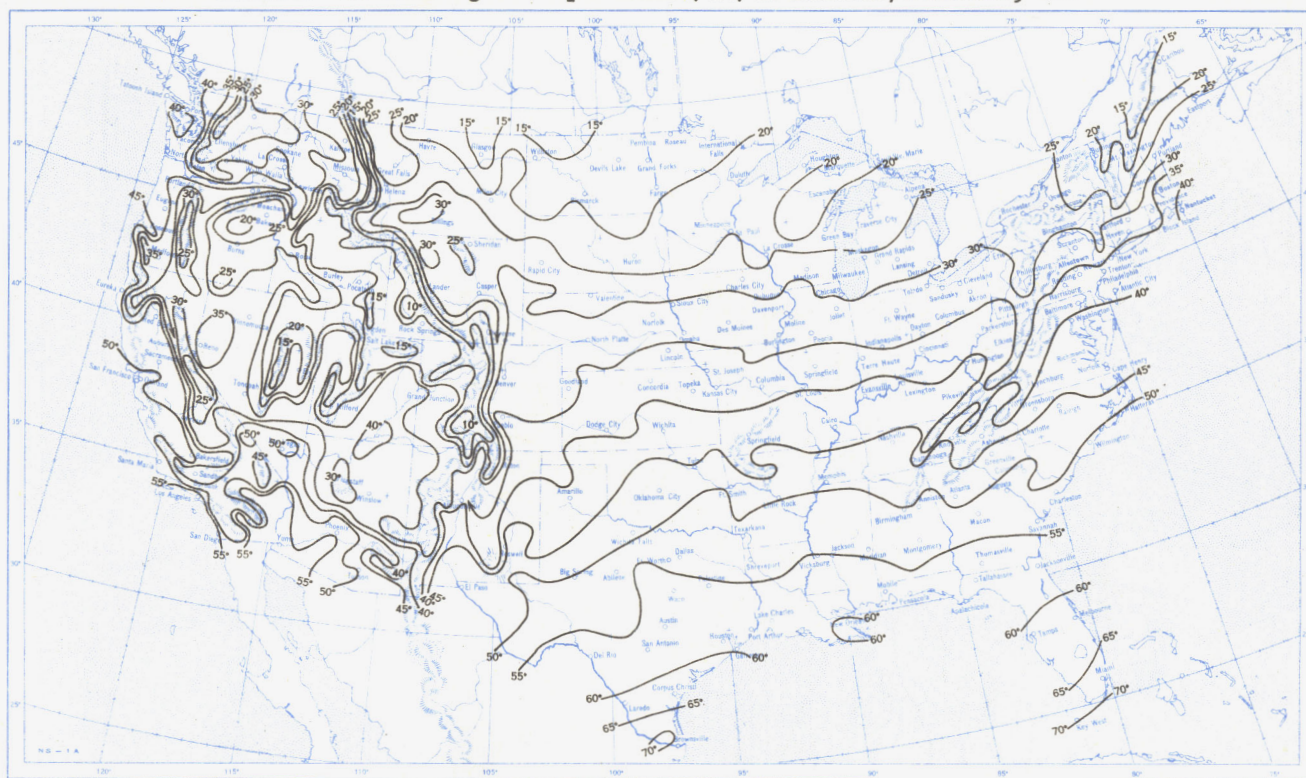
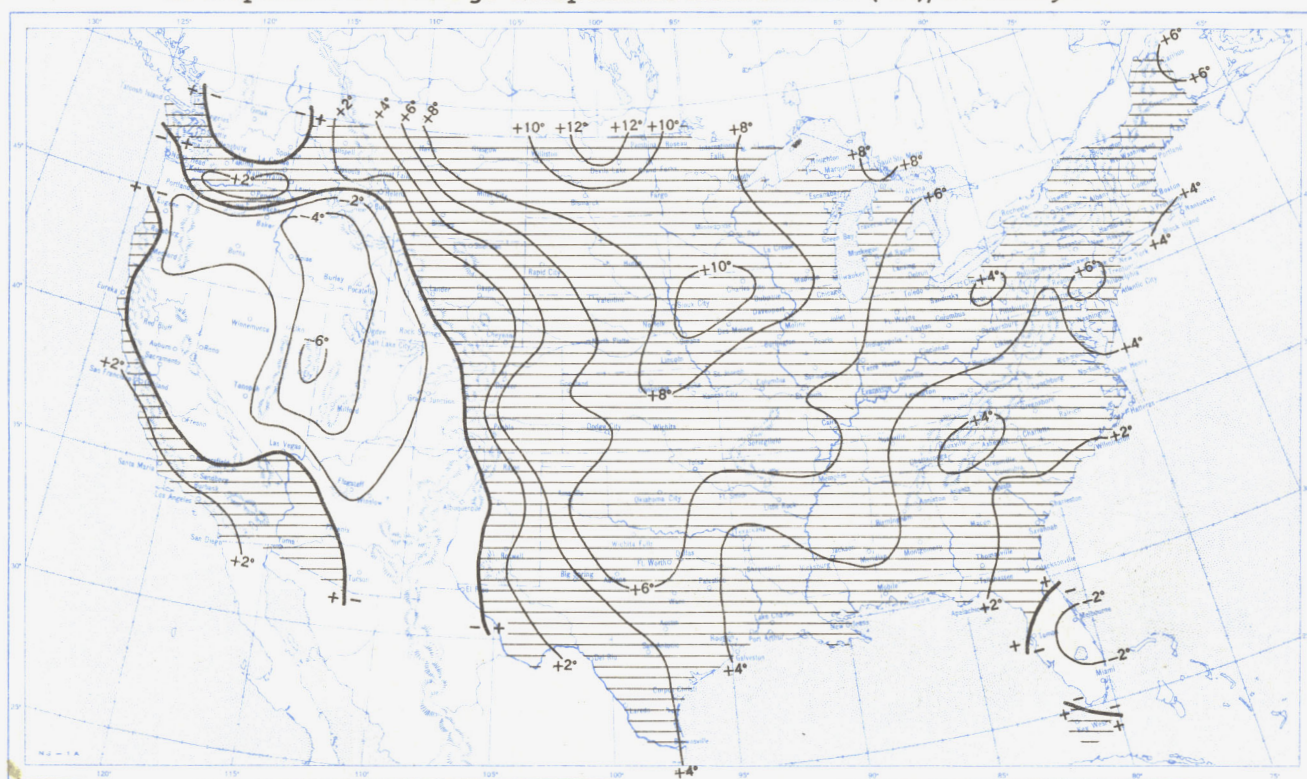


FIGURE 6. — Change in weekly mean surface temperature departure from normal from week ending February 12, 1952 (fig. 5A) to week ending February 26, 1952 (fig. 5B). Areas of negative changes between 5° and 20° F. are stippled while those in excess of 20° F. are more heavily stippled. Areas of positive change greater than 5° F. are hatched.

1040 mb. Since this one High prevailed over eastern Canada for such a long period while cyclones were generally absent, it is not surprising that monthly mean sea level pressure and 700-mb. height (Chart XI Inset and fig. 7) were considerably above normal through the entire region.

Even though the circulation and accompanying temperature regimes went through such large changes during the month in connection with the pronounced index cycle, the monthly mean circulation pattern and its anomaly still show a close relation to the monthly mean surface temperature anomalies over the United States (fig. 7 and Chart I-B). Although both the ridge over the western United States and the trough off the East Coast were slightly stronger than normal, the reversal of 700-mb. height anomaly pattern over Canada (i. e., above-normal heights in the trough, below-normal heights in the ridge) led to generally warm weather in most sections east of the Divide. Thus, the 700-mb. flow across most of Canada and the northern border of the United States was less northerly than normal, making strong outbreaks of continental polar air less frequent than normal for February, and at the same time allowing more opportunity for influxes of warmer air into the Canadian source region. The paucity of Canadian Highs crossing into the United States east of the Divide is quite evident in Chart IX. On the other hand, a large number of fast-moving cyclones traveled almost due eastward across southern Canada (Chart X) and probably led to frequent incursions of mild maritime Pacific polar air. Cool weather observed west of the Divide is very hard to explain on a monthly mean basis, but it may have been due to the presence of relatively weak anticyclonic flow aloft over a stronger than normal mean sea level Basin High (Chart XI). These conditions allow considerable radiational cooling especially when there is a substantial snow cover on the ground,

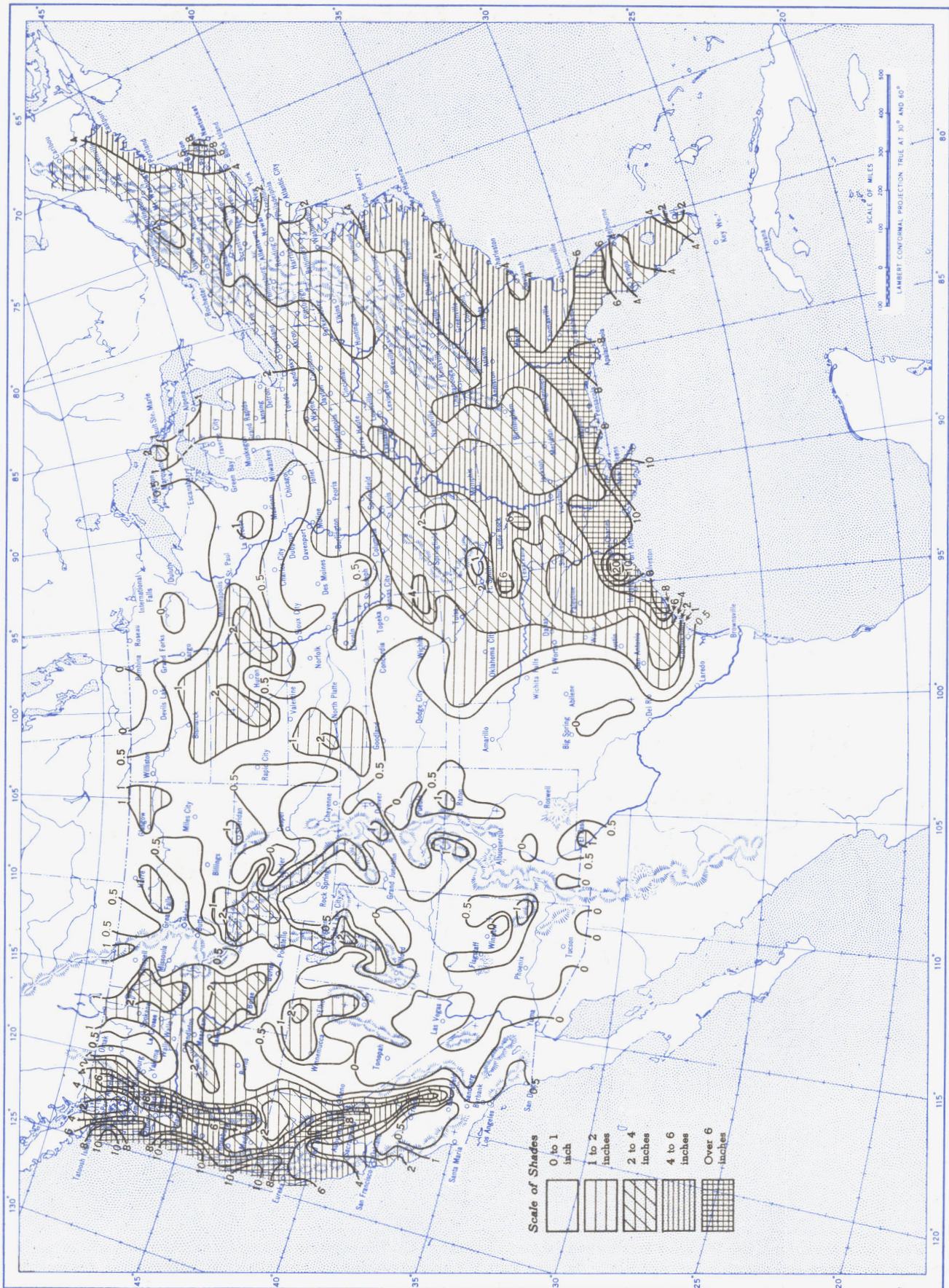
² These storms are discussed in detail by Carr (see p. 28 of this issue of the *Monthly Weather Review*) and by Ludlum in the April 1952 issue of *Weatherwise*.

Chart I. A. Average Temperature ($^{\circ}\text{F.}$) at Surface, February 1952.B. Departure of Average Temperature from Normal ($^{\circ}\text{F.}$), February 1952.

A. Based on reports from 800 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.

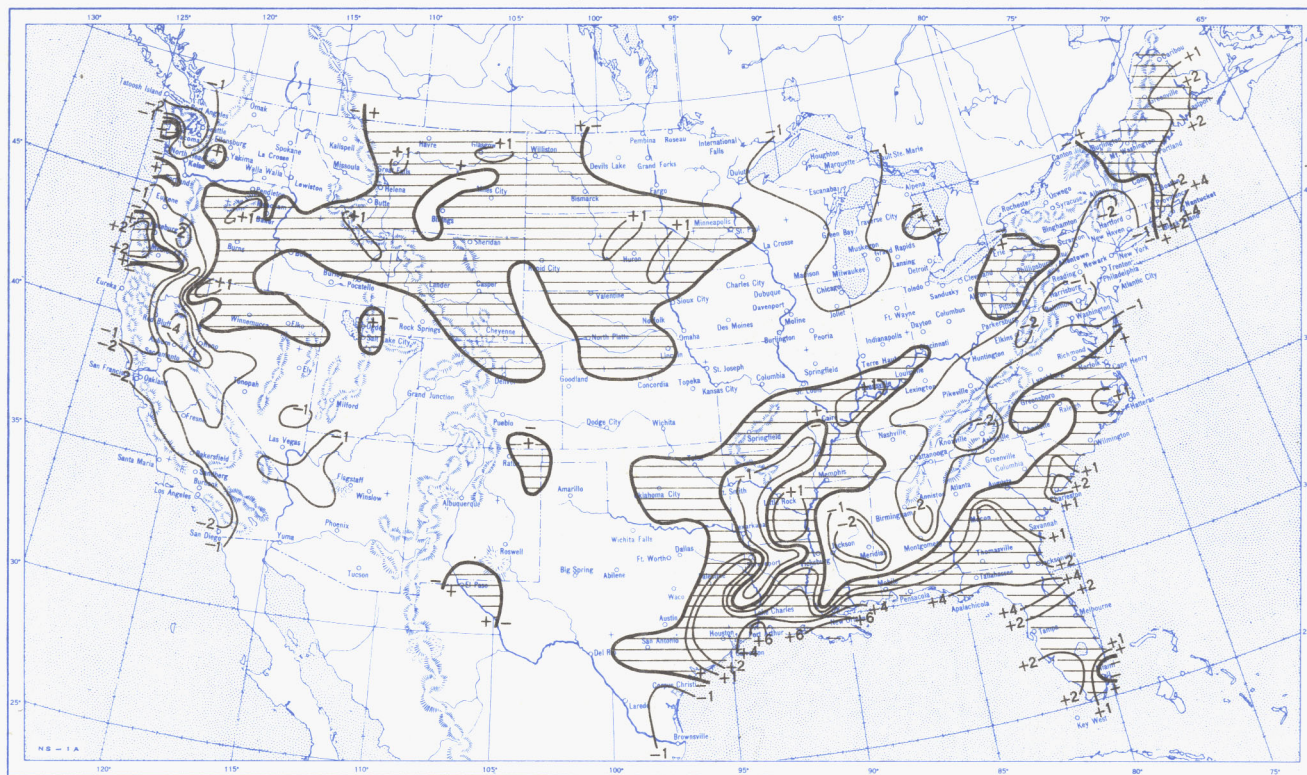
B. Normal average monthly temperatures are computed for Weather Bureau stations having at least 10 years of record.

Chart II. Total Precipitation (Inches), February 1952.

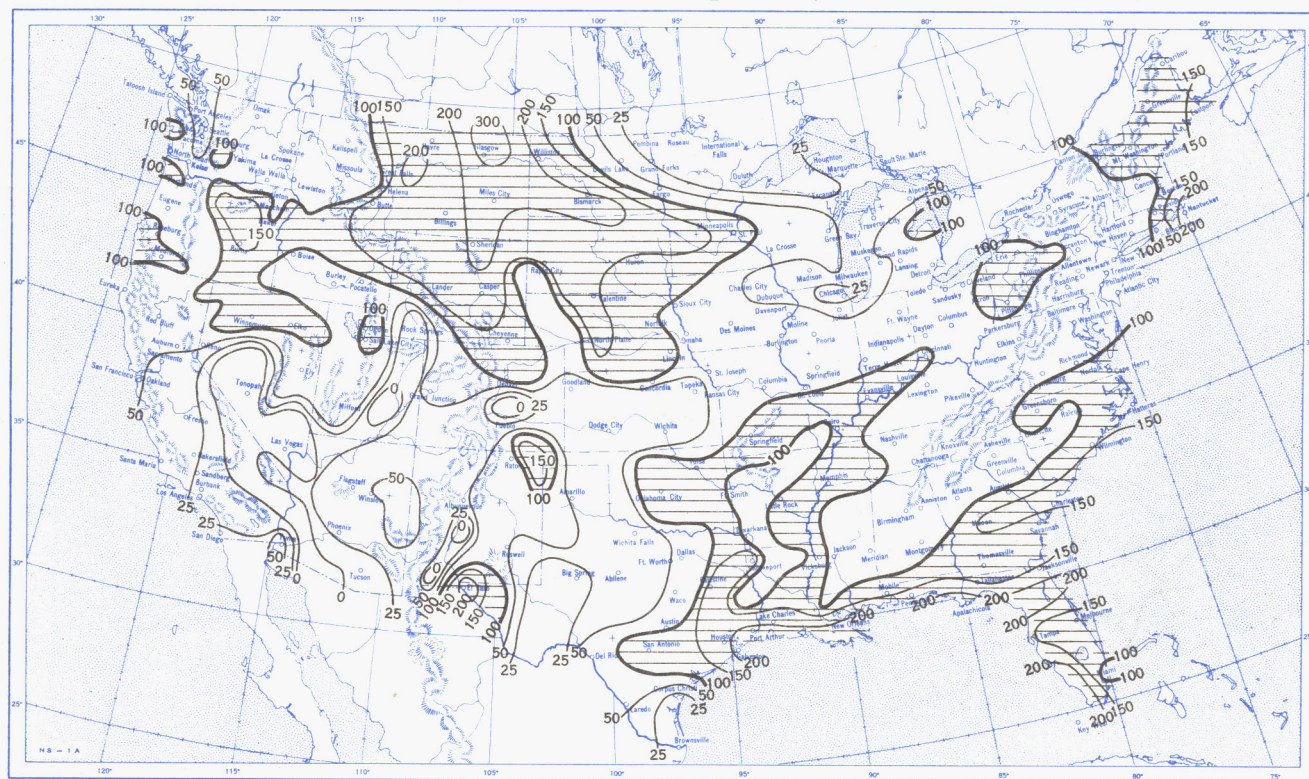


Based on daily precipitation records at 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), February 1952.

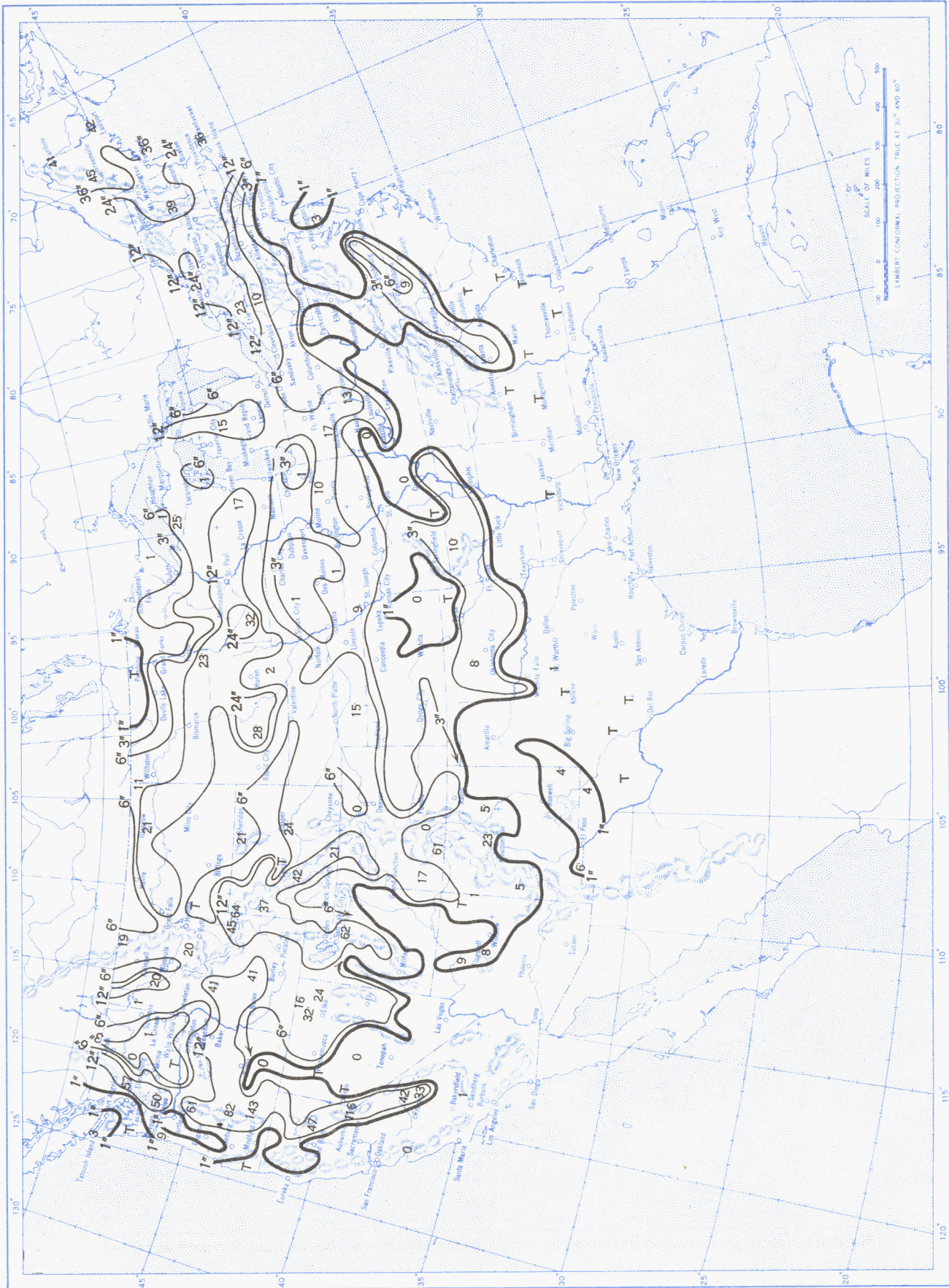


B. Percentage of Normal Precipitation, February 1952.



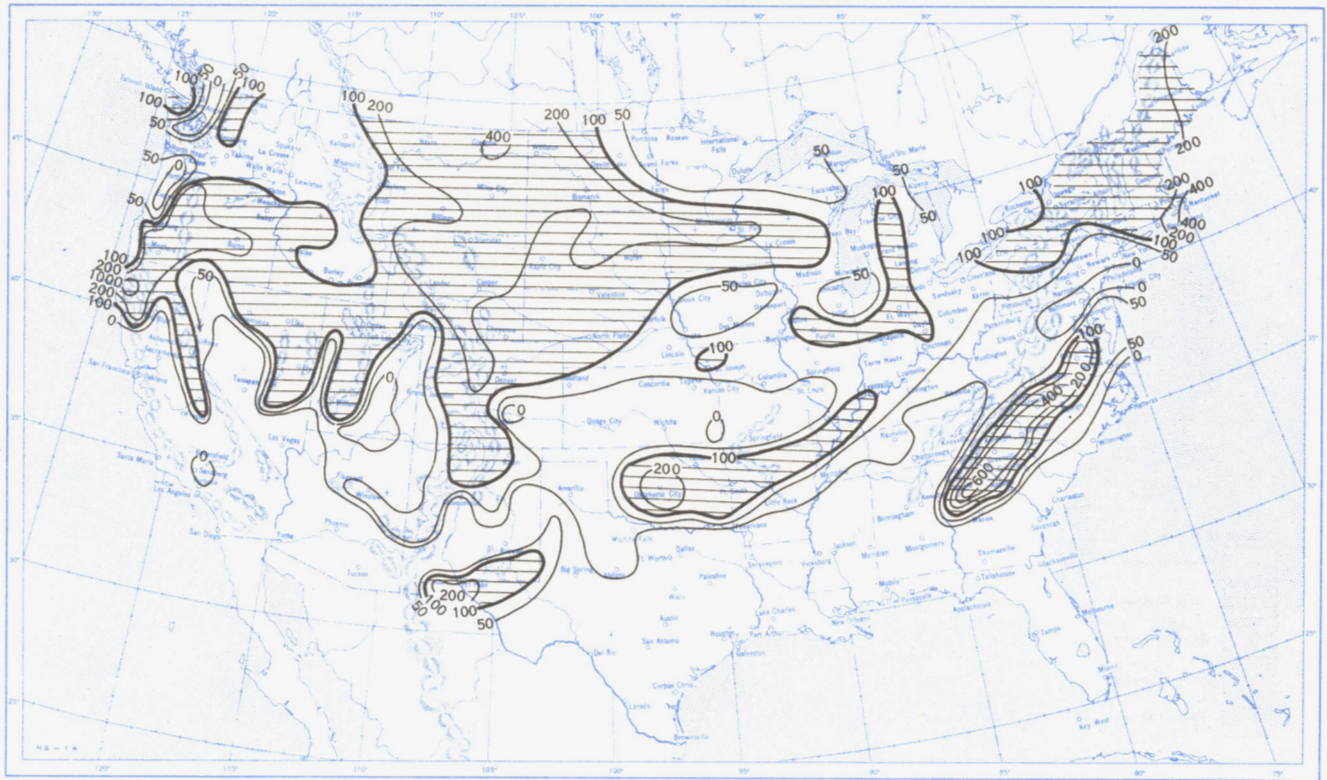
Normal monthly precipitation amounts are computed for stations having at least 10 years of record.

Chart IV. Total Snowfall (Inches), February 1952.

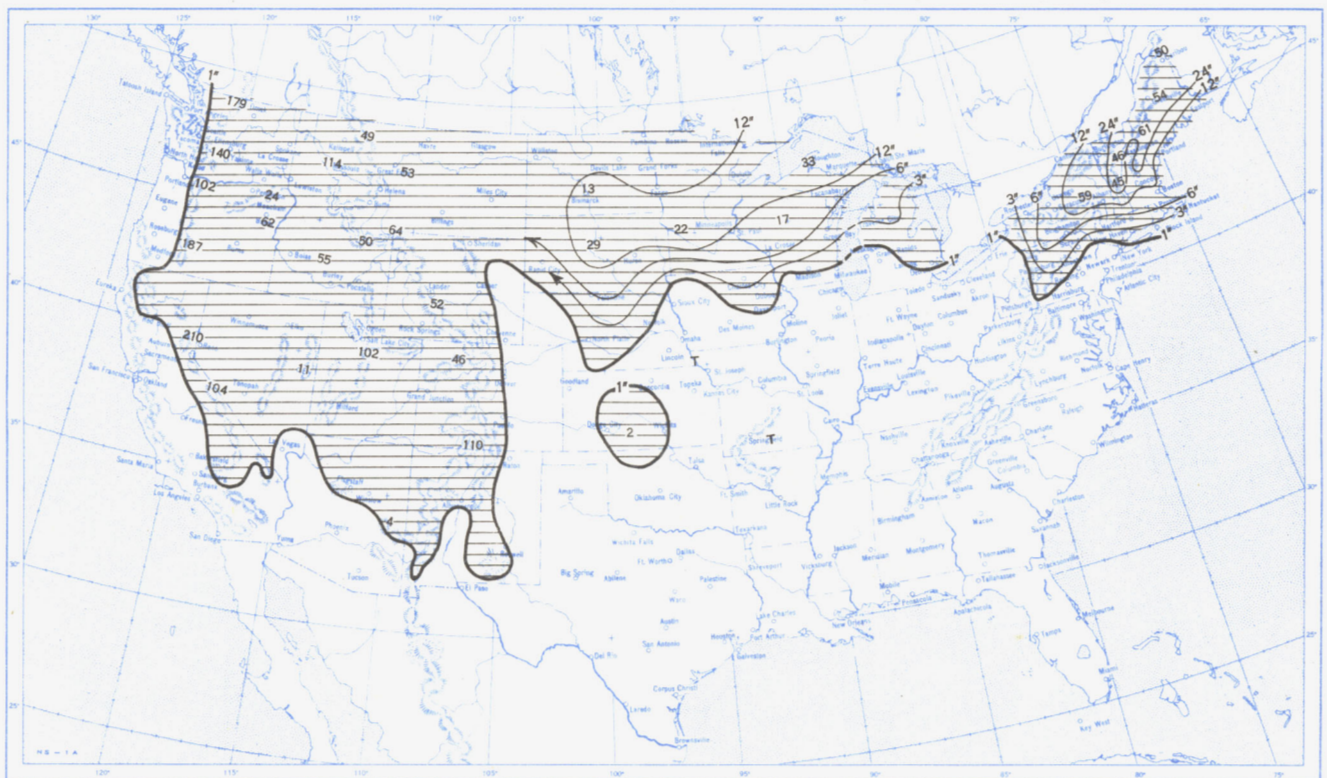


This is the total of unmelted snowfall recorded during the month at Weather Bureau and cooperative stations. This chart and Chart V are published only for the months of November through April although of course there is some snow at higher elevations, particularly in the far West, earlier and later in the year.

Chart V. A. Percentage of Normal Snowfall, February 1952.

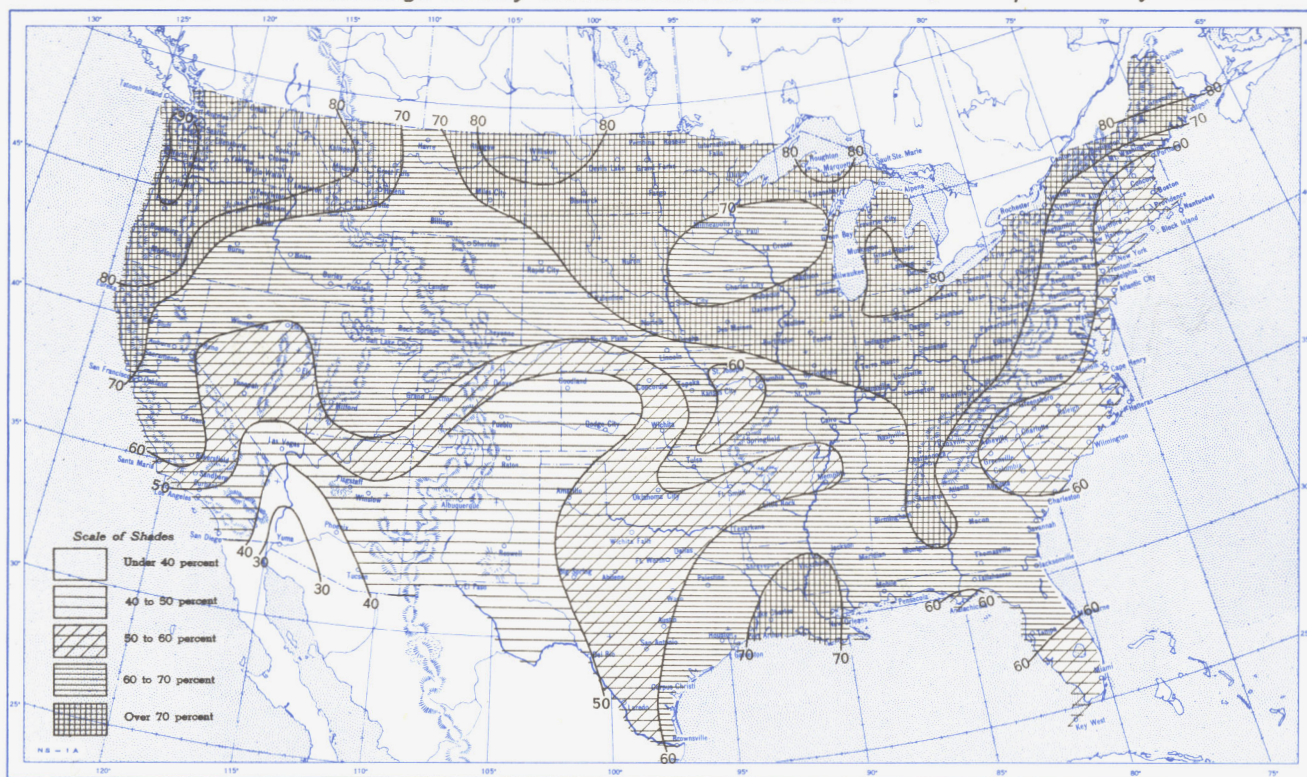


B. Depth of Snow on Ground (Inches), 7:30 a. m. E. S. T., February 26, 1952.

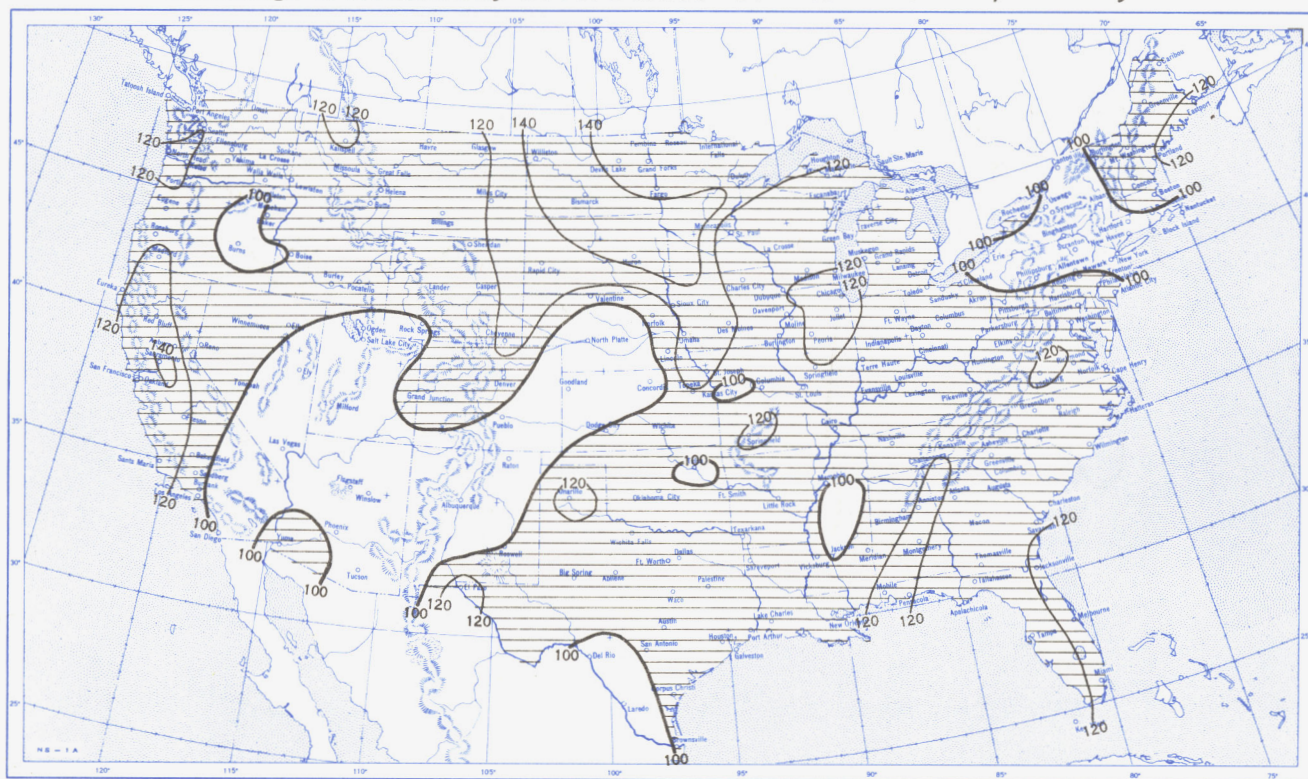


A. Amount of normal monthly snowfall is computed for Weather Bureau stations having at least 10 years of record.
 B. Shows depth currently on ground at 7:30 a. m. E. S. T., of the Tuesday nearest the end of the month. It is based on reports from Weather Bureau and cooperative stations. Dashed line shows greatest southern extent of snowcover during month.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, February 1952.

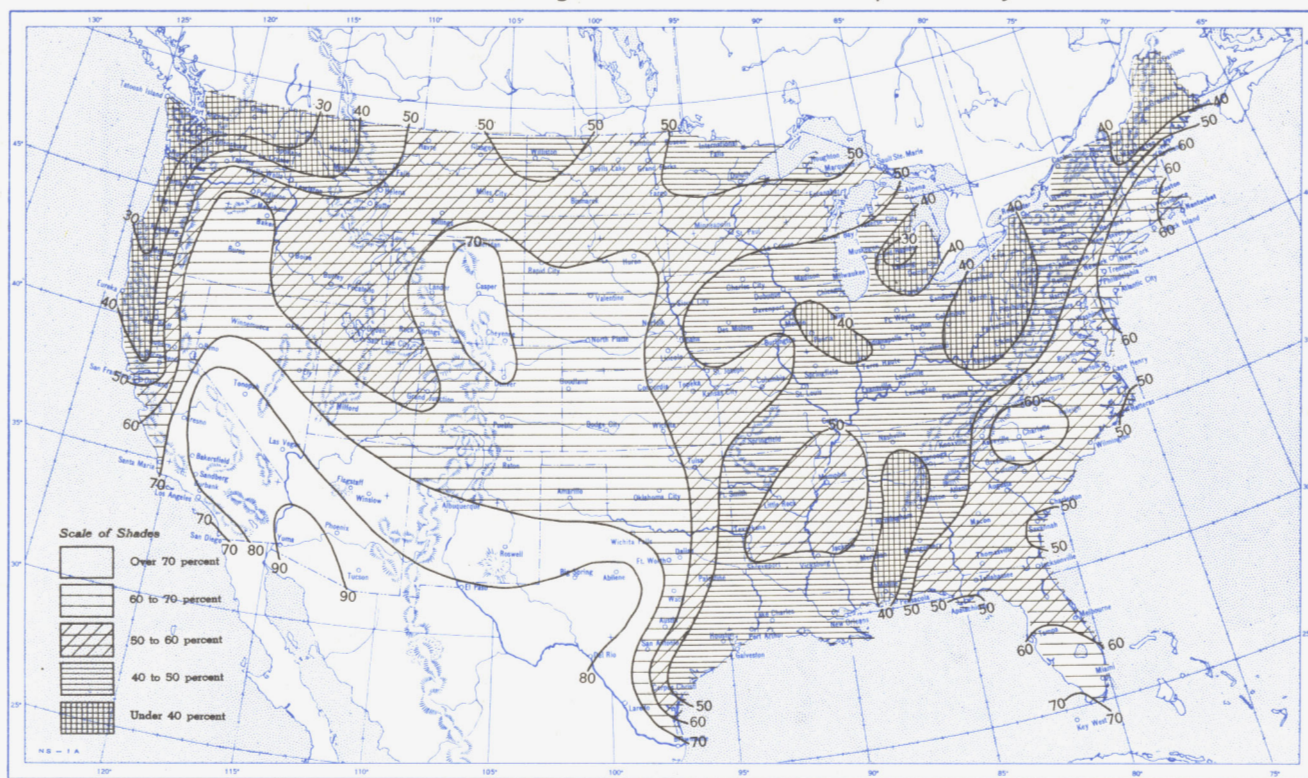


B. Percentage of Normal Sky Cover Between Sunrise and Sunset, February 1952.

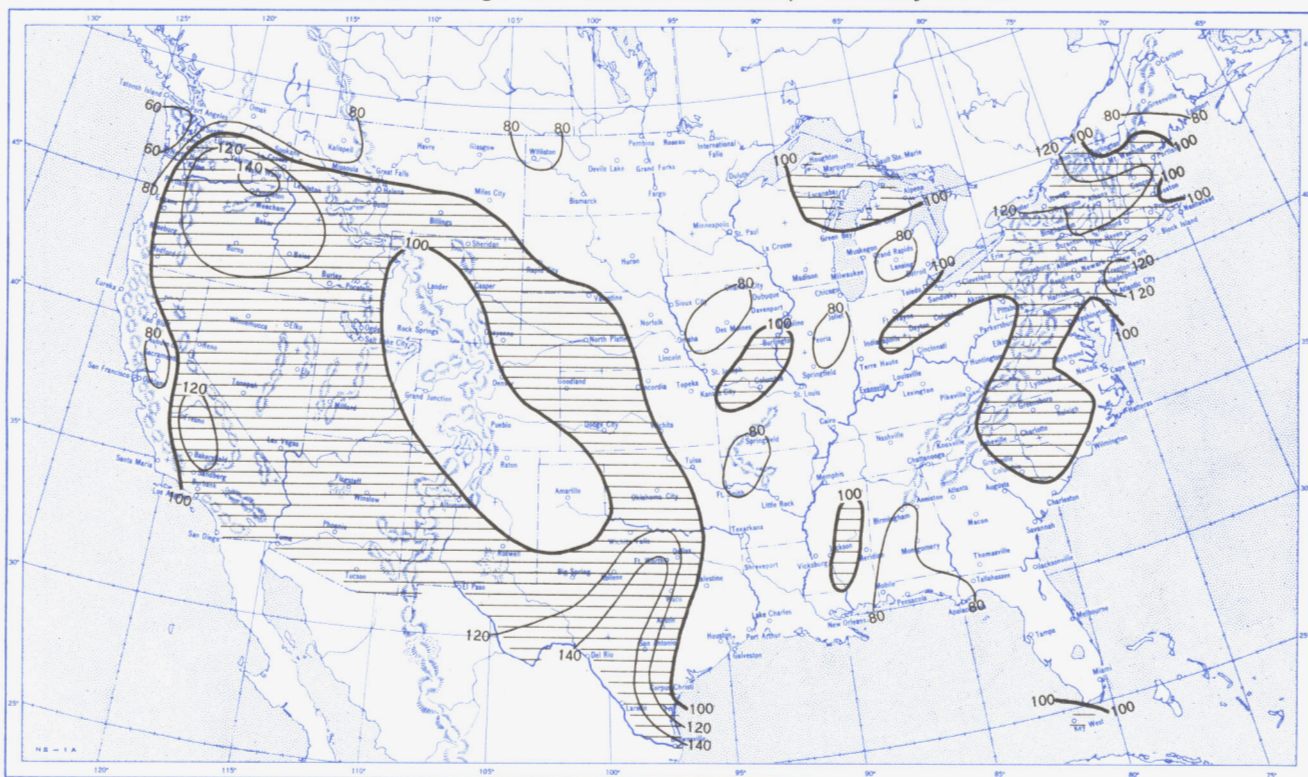


A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.

Chart VII. A. Percentage of Possible Sunshine, February 1952.



B. Percentage of Normal Sunshine, February 1952.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.

Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, February 1952. Inset: Percentage of Normal Average Daily Solar Radiation, February 1952.

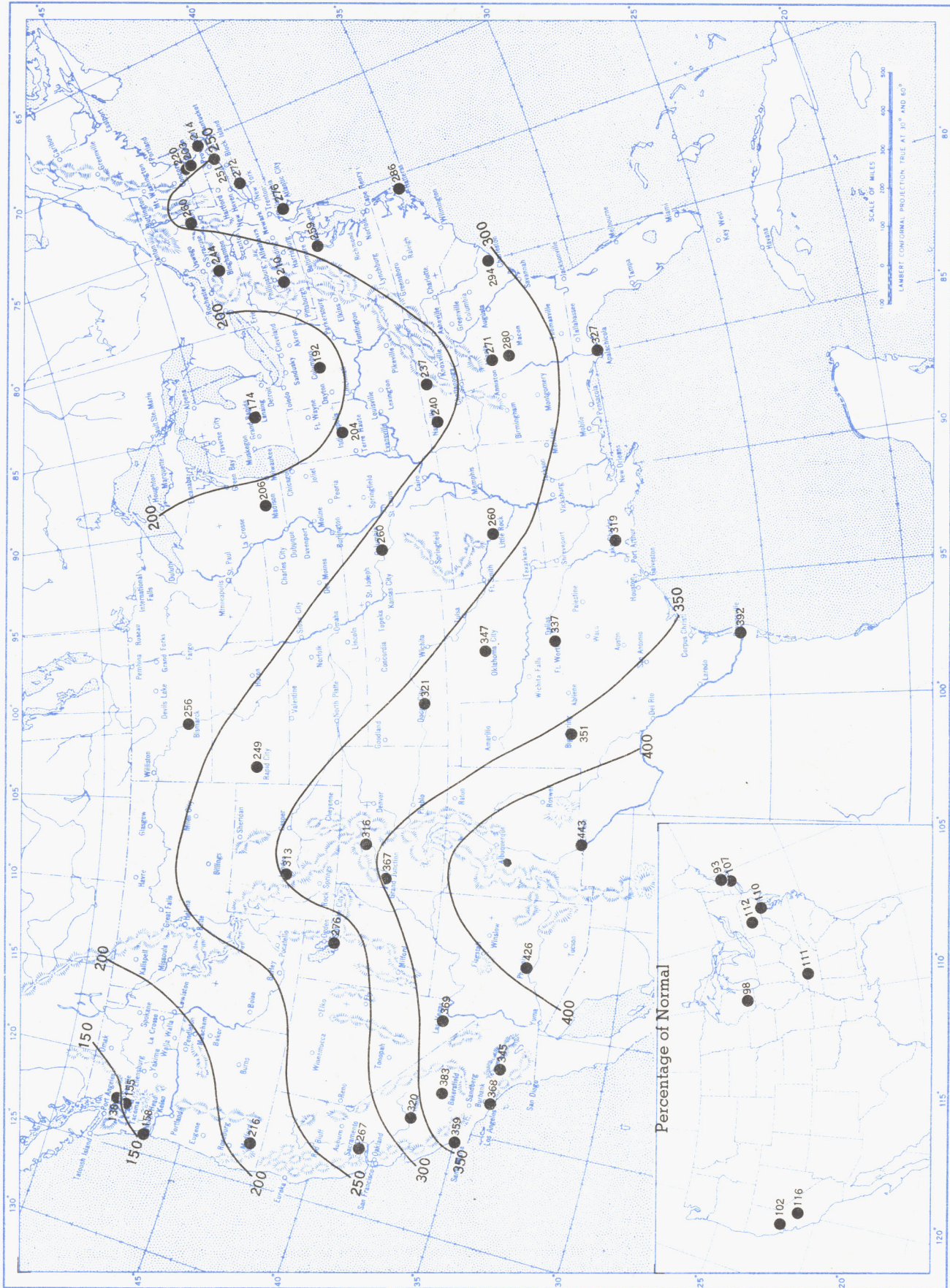


Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langleys (1 langley = 1 gm. cal. cm. $^{-2}$). Basic data for isotherms are shown on chart. Further estimates obtained from supplementary data for which limits of accuracy are wider than for those data shown. Normals are computed for stations having at least 9 years of record.

Chart IX. Tracks of Centers of Anticyclones at Sea Level, February 1952.

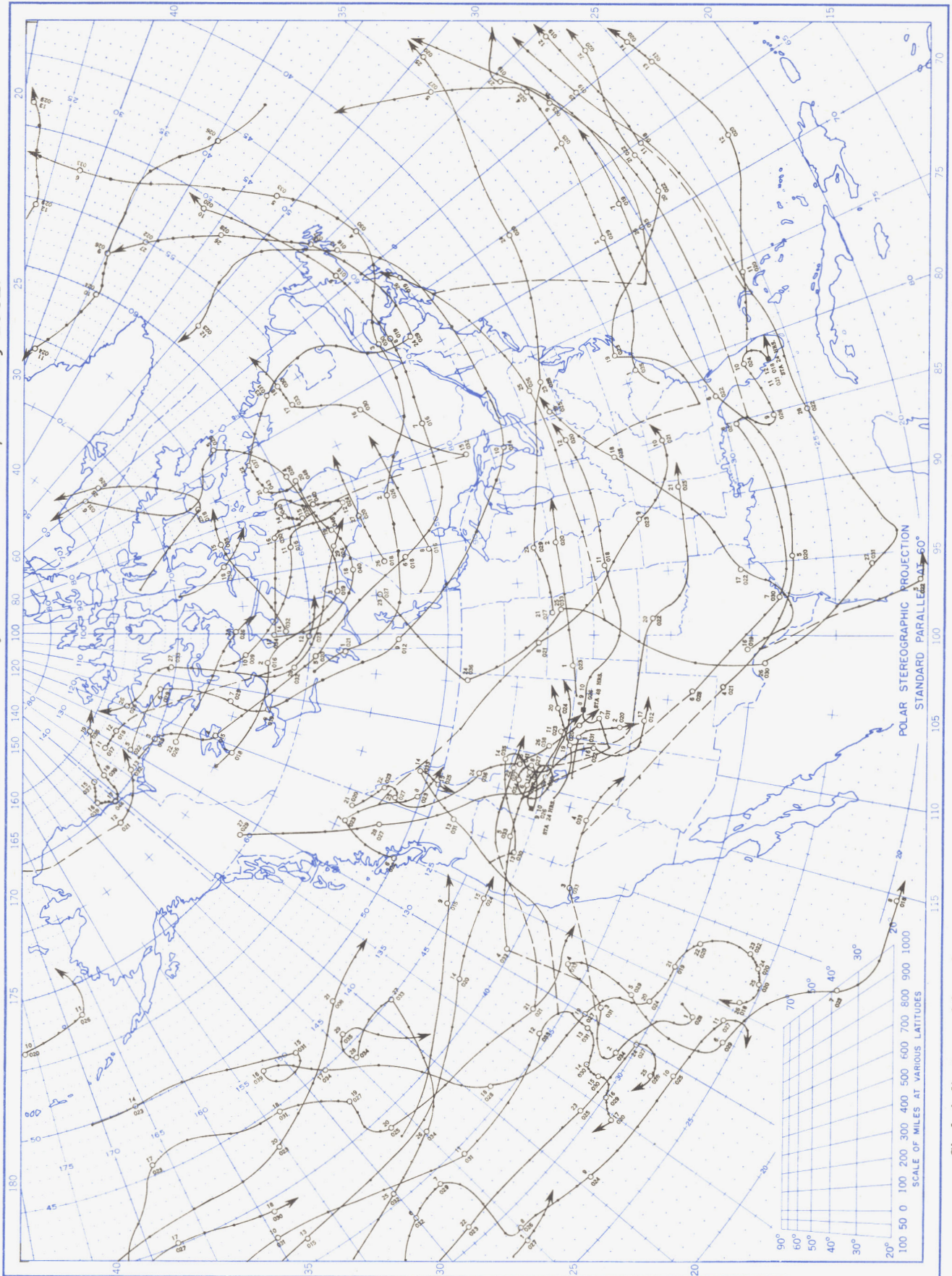
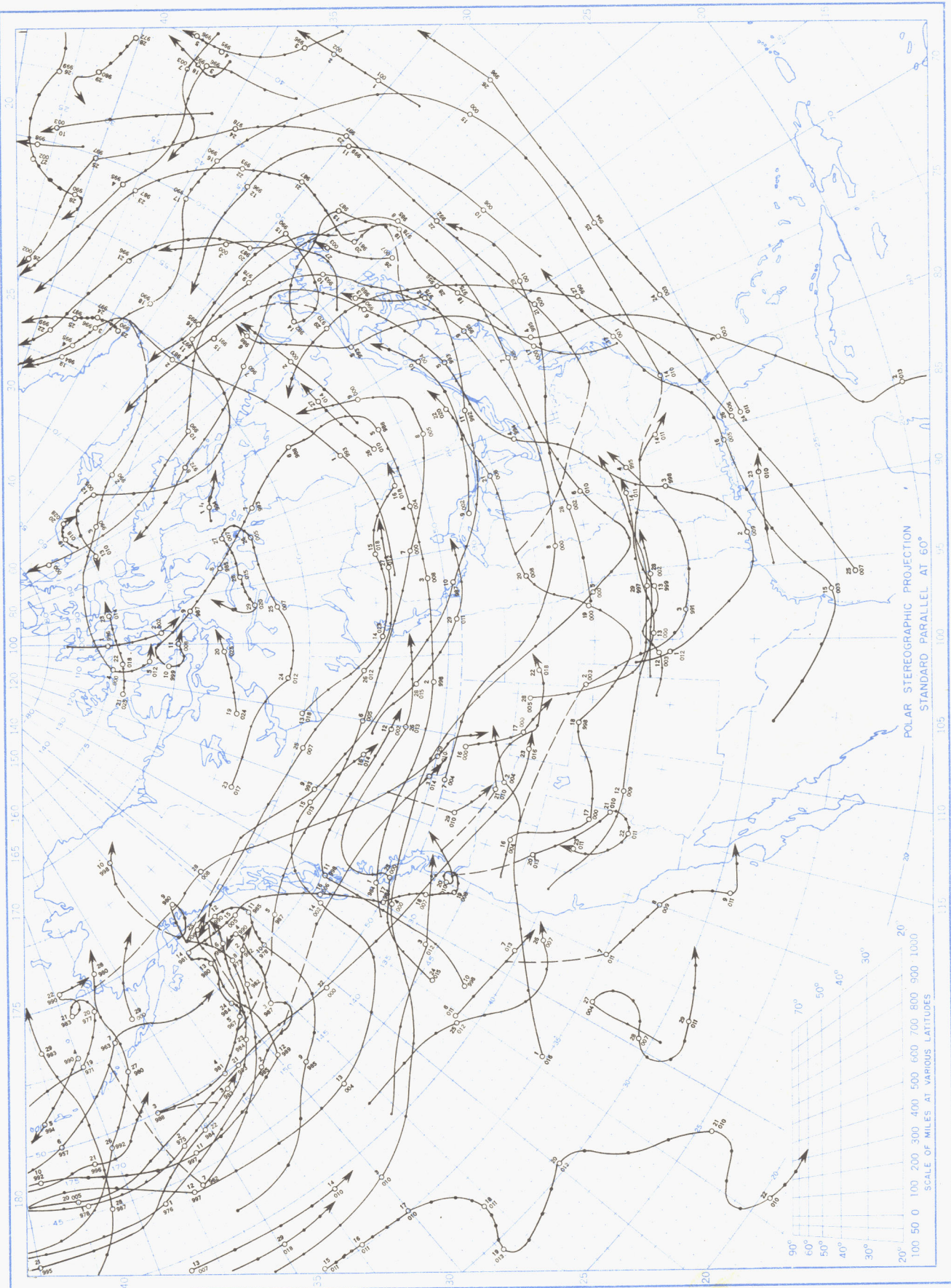
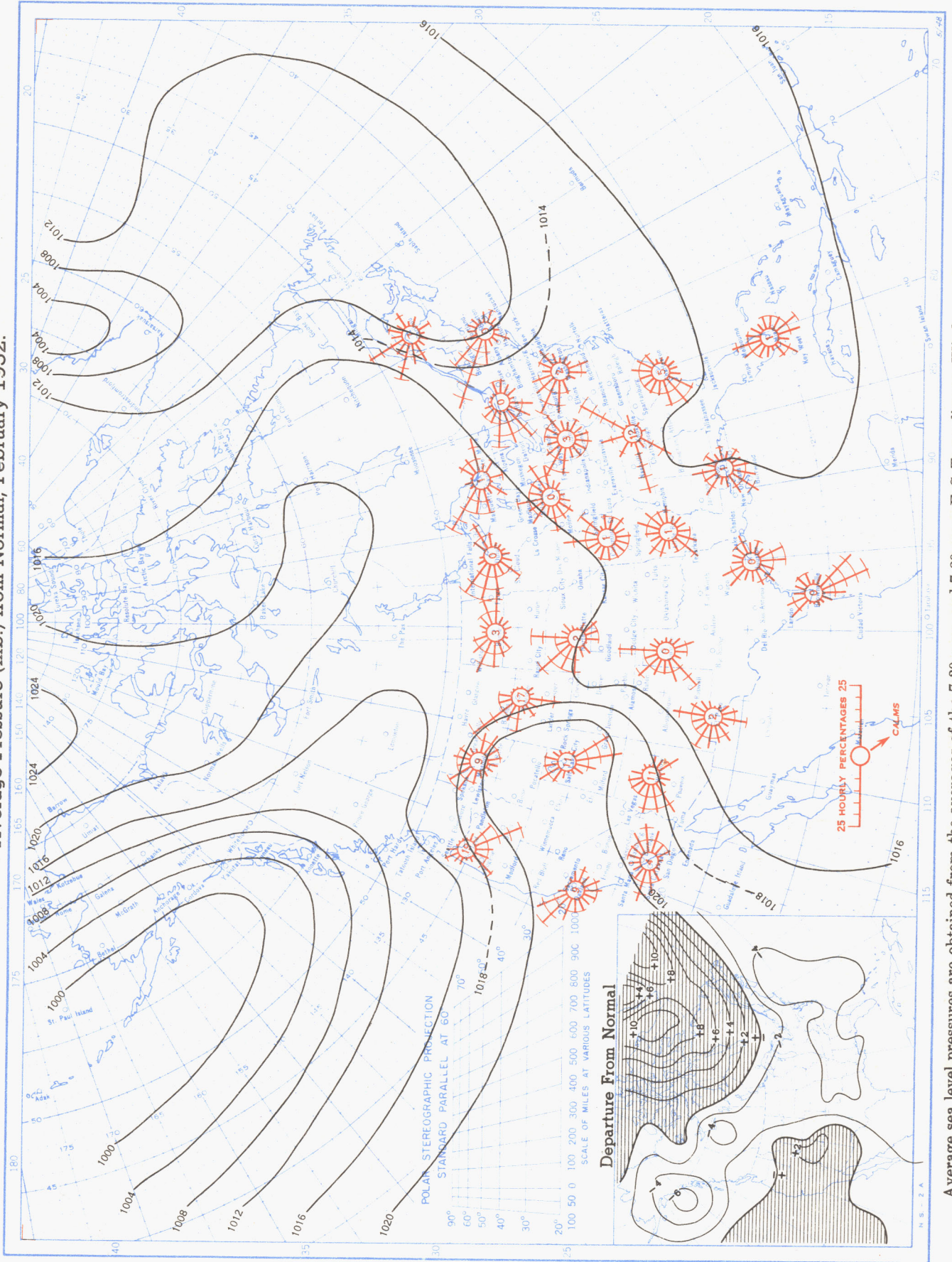


Chart X. Tracks of Centers of Cyclones at Sea Level, February 1952.



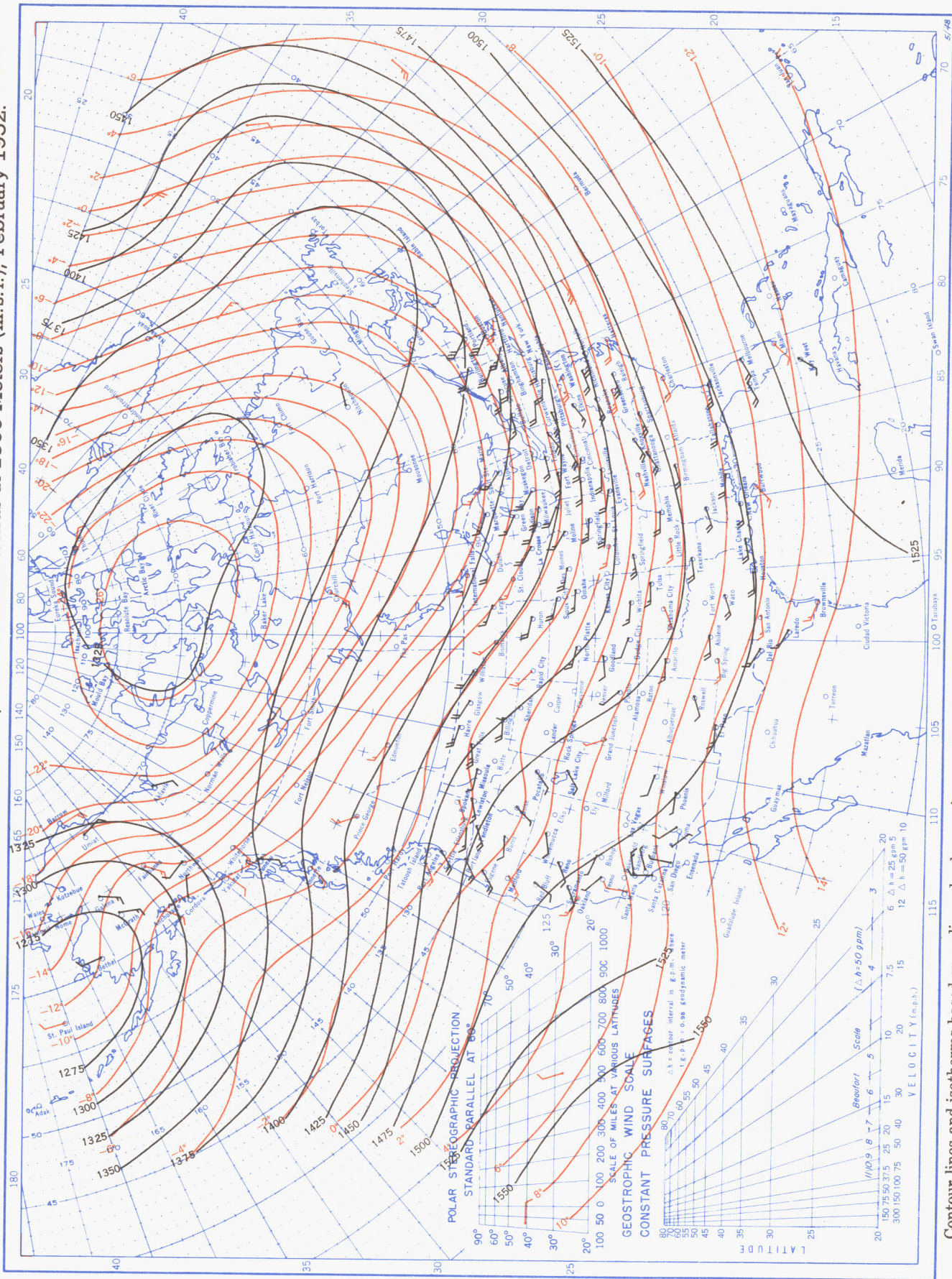
Circle indicates position of center at 7:30 a. m. E. S. T. See Chart IX for explanation of symbols.

Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, February 1952. Inset: Departure of
Average Pressure (mb.) from Normal, February 1952.



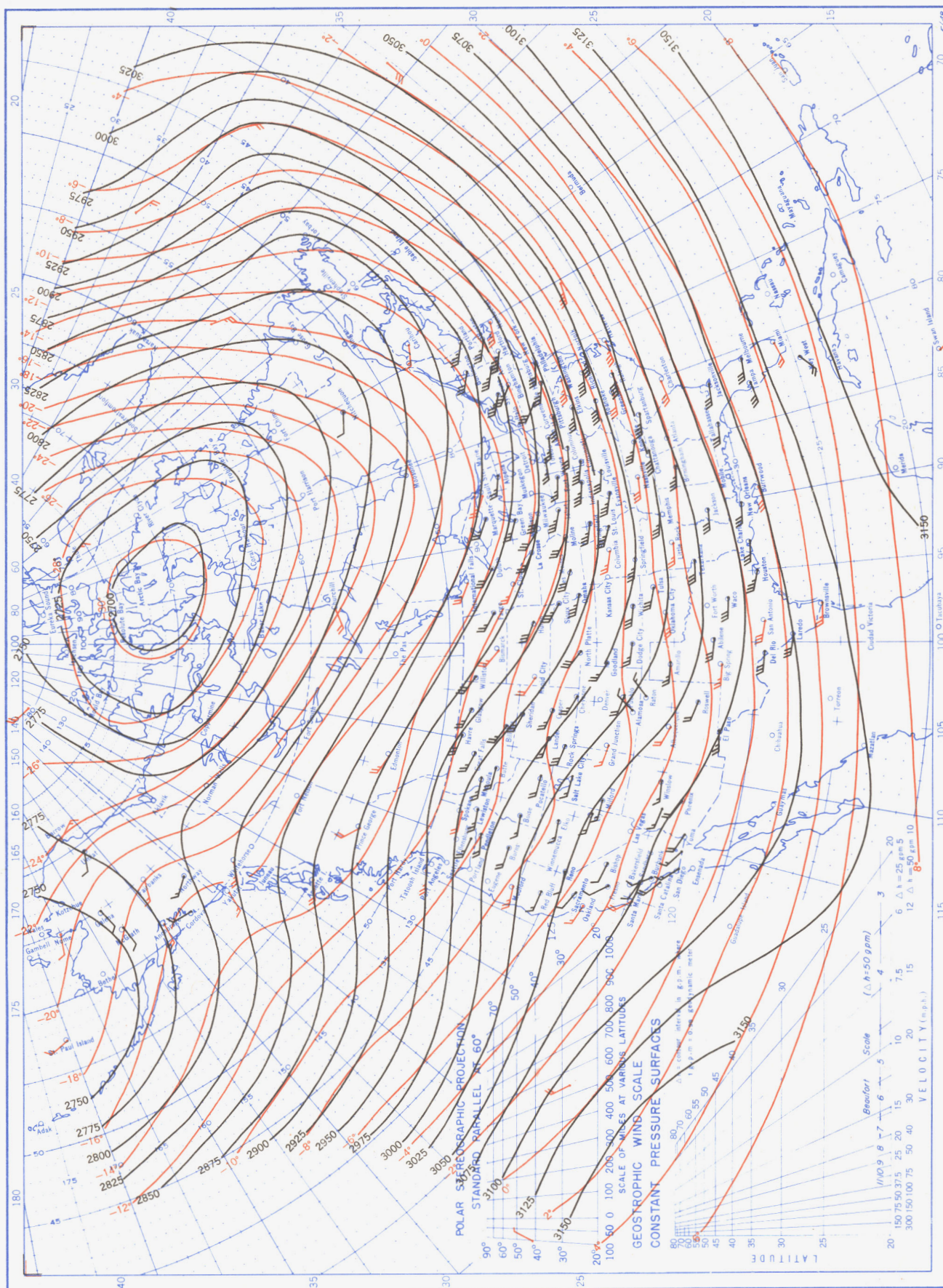
Average sea level pressures are obtained from the averages of the 7:30 a. m. and 7:30 p. m. E. S. T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° intersections in a diamond grid based on readings from the Historical Weather Maps (1899-1939) for the 20 years of most complete data coverage prior to 1940.

Chart XII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 850-mb. Pressure Surface, Average Temperature in °C. at 850 mb., and Resultant Winds at 1500 Meters (m.s.l.), February 1952.



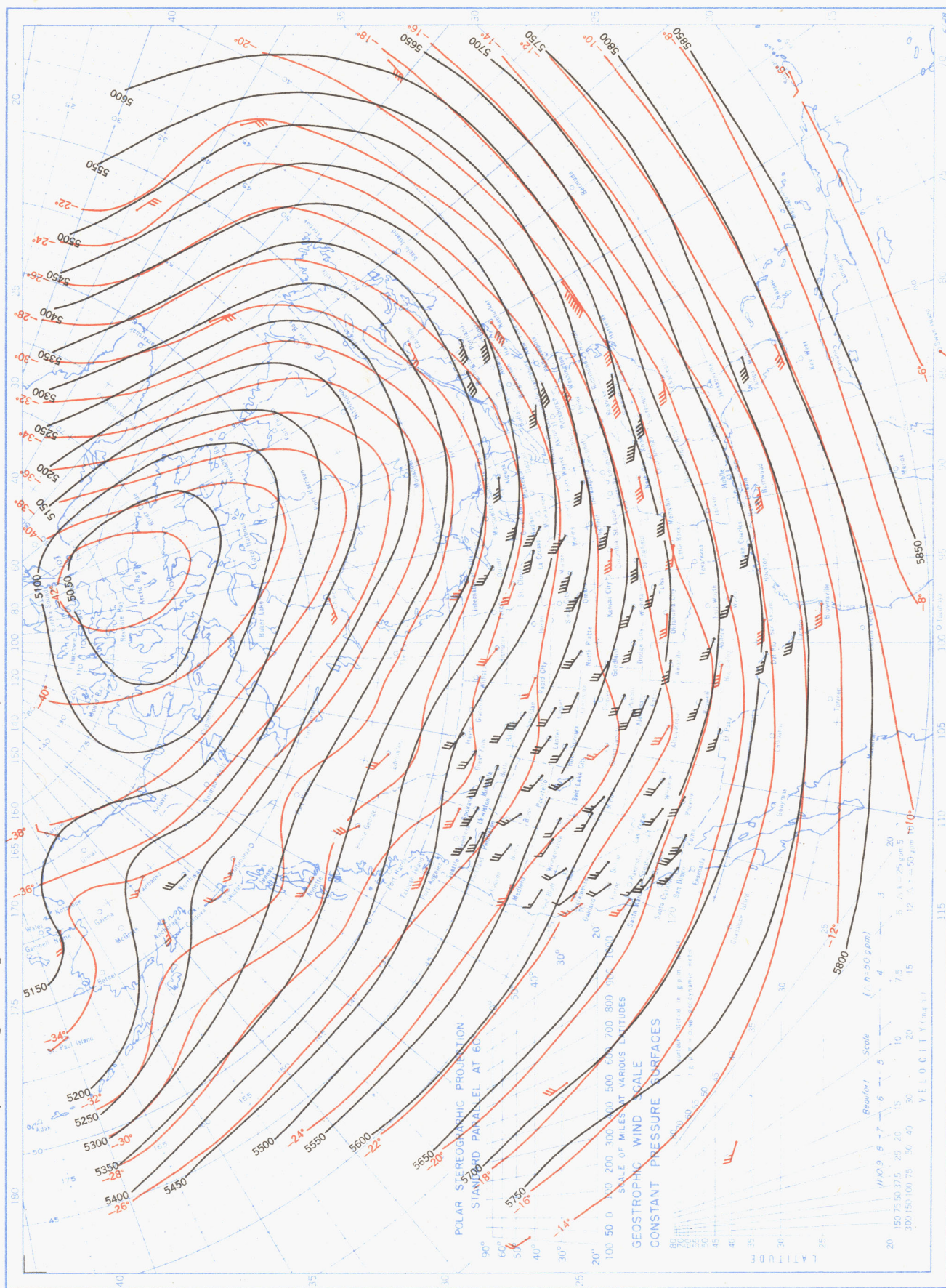
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

Chart XIII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 700-mb. Pressure Surface, Average Temperature in °C. at 700 mb., and Resultant Winds at 3000 Meters (m.s.l.), February 1952.



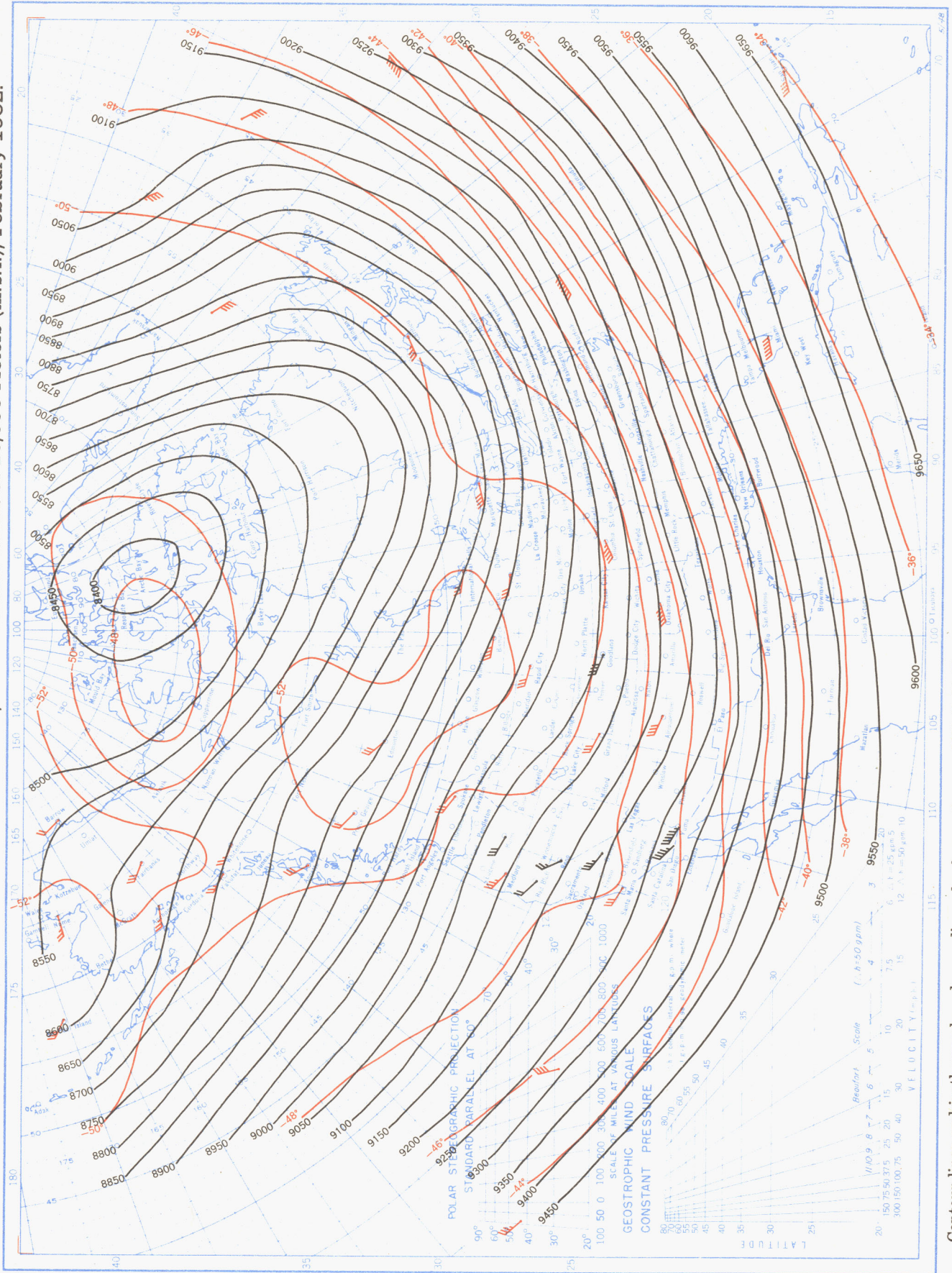
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

Chart XIV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 500-mb. Pressure Surface, Average Temperature in °C. at 500 mb., and Resultant Winds at 5000 Meters (m.s.l.), February 1952.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.

Chart XV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 300-mb. Pressure Surface, Average Temperature in °C. at 300 mb., and Resultant Winds at 10,000 Meters (m.s.l.), February 1952.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.